PART III

Physical Description

Physical Regions of Washington

On the basis of surface features, Washington may be divided into eight general regions. Agricultural settlement is influenced by factors of topography, climate, soil, forest vegetation, and water resources distinctive to each of the physiographic regions. Each has become a different type of farming area as settlers have learned to adapt crops and livestock to the conditions, or have improved limitations through drainage or irrigation.

Coastal Plains

A narrow, sandy plain with shallow bays, tidal flats, stream deltas, and low headlands lies between the coastline and the Coast Range. It extends from the Columbia River mouth almost to Cape Flattery, being widest and lowest in the Grays Harbor and Willapa Bay districts. The climate is mild and damp with a long growing season, but it is too cool, cloudy, and wet for most crops. Originally this area was covered with heavy forests and much is now covered with woodlands. Lumbering and manufacture of wood products is the main industry. Farming is largely of the livestock and dairying type on low uplands and drained areas in the lower Chehalis River Valley. Cranberry growing is important and well-adapted to numerous, boggy areas in the Grays Harbor and Willapa Bay sections. The shallow bays are also used for oyster culture. Fishing is common in the rivers and coastal banks.

Coast Range

The Coast Range is an uplifted area of sedimentary and metamorphic rocks divided into the Olympic Mountains and the Willapa Hills. The Olympics tower to nearly 8,000 feet in a dome-like structure, carved deeply by rivers. These mountains have the heaviest precipitation in the state. Snowfields and heavy forest cover the mountains. Most of the wilderness area is within the Olympic National Forest and Olympic National Park, being managed for recreation, wildlife, and timber. Farm settlement is limited to some foothill river plains and coastal terraces such as the Dungeness and Port Angeles districts along the Strait of Juan De Fuca. Here in the lee of the mountains, rainfall is moderate and irrigation is practiced by some livestock farmers. The Willapa Hill country is wet, heavily forested, and carved into numerous narrow valleys. Logging is the main industry, combined with livestock farming in the upper Chehalis River Valley and along the banks of the Columbia River. Wet climate, hilly topography, and the difficulty of clearing stump land retards agriculture.

Willamette-Puget Sound Lowland

A broad lowland, described as a trough or valley, lies between the Coast Range and the Cascade Mountains. The northern part is the Puget Sound

Lowland which has been glaciated and occupied by the sea in the lowest sections. The continental glacier reached slightly south of Olympia. Under a warming climate it melted and geologists believe it receded about 25,000 years ago, leaving an infertile plain of moraines and outwash gravels, sands and clays known today as the Puget Glacial Drift Plain. Its rolling surface has numerous lakes and bogs. Most of the major cities--Seattle, Tacoma, Everett, Bellingham and Olympia--have been built on moraines bordering the Sound. Rivers such as the Nooksack, Skagit, Snoqualmie, White and Puyallup built up deltas and flood plains over the older gravelly plains. These narrow valleys are more fertile than the older glacial plains, and support numerous small dairy, vegetable and berry farms. Most of the gravelly areas are wooded with a second-growth forest and are used for pastures. In the southern part of the Willamette-Puget Sound Lowland, there are two large valleys--the Cowlitz and Chehalis. They drain a low, hilly area with several flat prairies and bottom lands.

Agriculture is handicapped by poor drainage and flooding of the river deltas and plains, by heavy winter rainfall, by cloudy but dry summers, by coarse, gravelly upland soils, and by densely wooded land which is costly to clear. Advantages are mild climate and a location close to major markets for farm products such as milk, poultry and vegetables.

Cascade Mountains

The Cascades are a wide and high topographic and climatic barrier which separates western and eastern Washington. The range is made up of sedimentary, igneous and metamorphic rocks which have been carved by glaciers and streams. High isolated volcanic cones of lava such as Mt. Adams (12,307 feet), Mt. Rainier (14,408 feet), and Mt. Baker (10,791 feet), appear upon the older Cascade rocks. The Cascade crest varies between 10,000 and 3,000 feet and is higher and more rugged in northern Washington. Roads and railroads have been built across its lower passes in central and southern Washington. The Columbia River has cut a deep gorge and the lowest pass through the barrier. The western slope is wet and heavily forested with Douglas fir. The eastern slope is drier with a less-dense pine forest. Nearly all classified as forest land, most of the area is in Federal ownership in five national forests and Mount Rainier National Park. Tree fruit farming in the eastern slope valleys of Wenatchee, Chelan, Methow, Naches and the Columbia Gorge is most important. Sheep and cattle summer grazing on alpine grasslands is another use. Deep western slope valley bottoms such as the Skagit, Snoqualmie, Nisqually, Cowlitz and Lewis also contain livestock farms. The area is vitally important as a source of water for irrigation and city drinking water and as a source of timber. Steep terrain, wet climate, short growing seasons and heavy forest vegetation are main handicaps for agriculture.

Columbia Basin

A low plateau of old lava rocks covered with stream and wind-deposited soils extends in a series of plains, ridges, coulees and hills from the Cascades to the eastern Washington border. The area is basin-like in structure, being higher around its margins and sloping inward to low and level central plains. It has been sharply eroded by the Columbia River and

its interior tributaries, the Snake, Yakima, Palouse, and Spokane Rivers. The basin has sub-areas created by crustal movements and erosion.

The Yakima Folds are a series of hilly ridges extending from the Cascades eastward into the lower part of the basin. The Yakima and Columbia Rivers have cut gaps through the ridges, and built up plains in the troughs between them. The rich, alluvial plain of the Yakima River is an important irrigated valley.

The Waterville Plateau is a tableland of thin soils overlaying basaltic rock at an elevation of 2,500 to 3,000 feet. It has gorges cut by the Columbia River and ancient glacial outwash streams once flowing in Moses and Grand Coulees. It is too high for irrigation and is used for dryland grain and livestock farming. The high plain is often called the Big Bend country.

The Channelled Scablands is a belt of dry terrain carved by ice-age rivers into a series of coulees. Bare rock is exposed in the coulees. Small plateaus between the old river channels have thin soils used for dryland farming. The Grand Coulee of this region has been developed into a major irrigation reservoir.

The Palouse Hills consist of fertile deposits of wind-blown soil overlaying basaltic lava flows. After being deposited in large dunes, the formation was reshaped by streams into an intricate pattern of low, rounded hills which are tilled for wheat, barley, and legumes. The hills receive 16 to 25 inches of rainfall and have deep, porous and fertile soils. It is one of the richest farming areas of the Pacific Northwest.

The Central Plains are low and relatively level expanses of soil, deposited by old streams crossing the Channelled Scablands and later by the flooding of the Yakima, Columbia, Snake and Walla Walla Rivers. Climate is desert-like (6-12 inches of precipitation per year). The lower lands of the area, the Quincy and Pasco Basins and the Walla Walla Valley, are irrigated. Quincy Basin is a new irrigation area watered by Grand Coulee Dam.

Agricultural handicaps in Columbia Basin regions are mainly found in its dry, continental climate. Large irrigation systems built since 1900 have overcome much of the need for water on rich valley and basin soils. Dryland farming in higher areas is practiced widely, although occasional variations in rainfall, lack of snowfall, winter-kill, water and wind erosion inflict damage to field crops and to livestock ranges.

Okanogan Highlands

A portion of the Rocky Mountains, consisting of well-eroded old granites, lavas and sedimentary rocks extends across north central Washington. These are the Okanogan Highlands, the state's richest mineral area. Summit levels reach 4,000 to 5,000 feet with peaks exceeding 7,000 feet. Prominent north-south valleys are occupied by irrigated tree fruit and livestock farms. These are the Okanogan, Sanpoil, Kettle, and Colville Valleys. The Columbia River gorge through the Okanogan Highlands is occupied by the large man-made

lake behind Grand Coulee Dam--Roosevelt Lake. High and wetter portions are forested with pine and larch, and are managed for timber and for livestock ranges by the United States Forest Service and the Bureau of Indian Affairs. Cold winter temperatures, short growing seasons, dry valley climates and distance from markets are farming handicaps.

Selkirk Mountains

The Selkirks, a range of the Rocky Mountain system, extend into the northeast corner of Washington. The rocks are old mineralized granites and metamorphics reaching elevations of over 7,000 feet. The Pend Oreille River Valley at the base of the Selkirks is an agricultural area of narrow bottom lands settled by livestock farmers. Nearly all of the uplands are in Kaniksu National Forest. While climate is cool and growing seasons are short, the Pend Oreille Valley has an advantage of being closely located to the Spokane metropolitan market area.

Blue Mountains

The Blue Mountains are an uplifted and eroded plateau extending into the southeastern corner of Washington. The strata are mainly ancient crystalline rocks which contain some minerals. The highest point of the mountains in the Washington section is Diamond Peak (6,401 feet), on the divide between the Grande Ronde, Tucannon and Touchet Rivers. These rivers, and the Walla Walla River, have cut valleys into the plateau. Extensive pine forest and grassland areas are in the highlands within Umatilla National Forest, where rainfall is 30 to 40 inches. The Snake River has cut a deep valley and gorge across the lower parts of the mountains. The area is well developed agriculturally around its northern foothills where wind-blown soils are deep and irrigation systems are used. The Walla Walla and Tucannon Valleys are rich grain, legume and livestock areas grown under irrigation and by dry farming. Grazing is an important use of the high lands by livestock ranchers in the upper valleys.

Topography of Chelan County

Chelan County is located on the eastern slope of the Cascade Mountains. There are sharp contrasts between valley lowlands and the high alpine peaks and ridges which divide them. Elevations vary from 550 feet on the Columbia River in the southeast corner of the county to Mount Logan (9,080 feet) on the northern boundary of the Cascade divide. The inhabited valleys and benchlands along the Columbia are nearly everywhere overshadowed by the ridges and foothills of the Cascade Mountains. Over three-fourths of the county area is non-agricultural and mountain area.

From the standpoint of agriculture the most significant topographic features are three glaciated valleys and a narrow strip of benchlands bordering the present channel of the Columbia River. Lake Chelan and its lower valley is the most scenic of these valleys, now occupied largely by orchards. Chelan is one of the best examples of a glacial finger lake in America. It was gouged out by an alpine glacier during the Pleistocene ice age over 20,000 years ago. A deep moraine was left at its lower end and as the glacier melted it left a deep, narrow lake basin. Lake Chelan is the longest and largest of the natural

glacial lakes in Washington. At the lower part of the Chelan Valley on the glacial moraines and rolling terraces surrounding Manson and Chelan, there is an orchard area with an elevation of 1,080 to 1,500 feet.

The Entiat River, preceded by the Entiat Glacier, has carved a long, narrow valley in the center of Chelan County. The floor of the valley is 950 to 1,000 feet in elevation, deeply intrenched in the mountains which border it. The city of Entiat is near where the Entiat River joins the Columbia River. North of Entiat is a flat low benchland of alluvial soil, of 850 feet elevation, deposited in a bend of the Columbia River. This rich benchland is the main orchard section in the area.

The Wenatchee Glacier of geological history and the present Wenatchee River have eroded a valley whose bottom lands range between 1,000 feet and 795 feet in elevation. The Wenatchee River joins the Columbia in a flat benchland area of about 10 square miles in area. The Columbia River benchland surrounding Wenatchee to the west includes the major orchard and field crop district of the county. The middle and upper Wenatchee Valley has narrow bottom and benchlands with important orchard districts at Monitor, Cashmere, Peshastin, Dryden and Leavenworth. The Wenatchee valley leads up to Stevens Pass (4,061 feet) the second most important highway and railroad pass across the Cascades.

Land Classification and Soils

In general, mountain building, glaciation and the depositing of coarse materials by mountain streams have resulted in a large area of non-agricultural land in Chelan County. Productive farm land is limited to the narrow, valley plains and to some terraces deposited by the Columbia River in past stages of erosion. The land is divided into six general classes according to its capability for use although the soils have not been surveyed or mapped in detail. Soils fall into three general physical classes: (1) alluvial soils laid down by streams, (2) glacial soils deposited through glacial action, and (3) sedentary soils formed from parent material underlaying it. Chelan also has two chemical types of soils--pedalfers, which are formed in humid, forested regions and pedocals, which are formed in dry climates. Alluvial soils deposited in recent time by the principal rivers are the major farming soils in Chelan County. Nearly all the croplands are pedocal soils which are unleached and are rich in soluble minerals such as calcium, phosphorus and potash.

Class III land containing the best soils available in the county are limited in area. On a generalized map of land capability, the Class III lands consist of the low bottoms and terraces of the Wenatchee Valley where irrigation is possible. Another Class III section is the terrace between Chelan and Manson in the Chelan Valley, another irrigable area. These soils are gravelly, sandy and silt loams deposited by glacial, stream and some wind action. They are high in mineral content, but are slightly deficient in nitrogen and organic matter. Under irrigation these soils are well suited for tree fruits.

Class IV land with fair quality soils makes up most of the Entiat Valley, some of the benchlands around Lake Chelan, and the benchlands of the Columbia River between Wenatchee and Azwell. The soils are sandy and gravelly loams deposited by glacier and river with some wind-blown silt on the surface.

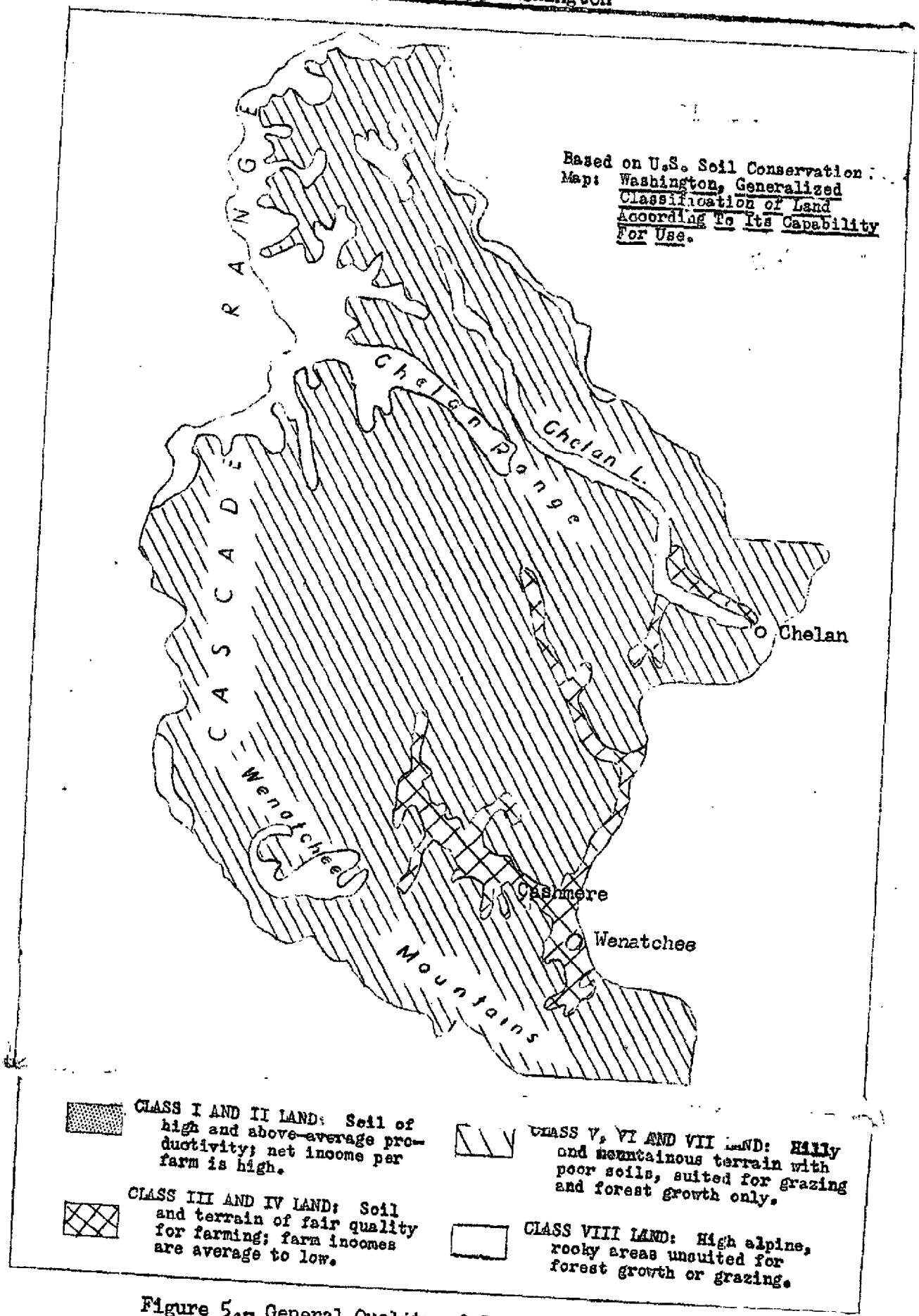

Figure 5.- General Quality of Land In Chelan County

Being of slightly higher elevation, 1,500 to 2,000 feet, they are in a zone of colder temperatures and shorter growing seasons.

The remainder and major part of Chelan County lands are steep, stony and rough mountain soils in Classes VI, VII and VIII. Some of these lands in plateaus and alpine ridges are suitable for summer grazing and are used by stockmen with grazing permits granted by Chelan, Wenatchee and Snoqualmie National Forests. Class VII land, a pine forested belt of 2,000 to 5,000 feet elevation, is the most extensive land type. Its soils are a forest type (podzolic) of low capability for farming, and were developed under more humid conditions. Cold temperatures and snowfall also limit their agricultural use. The highlands are classified as permanent forest lands.

Climate

Located on the eastern or leeward side of the Cascade Range, Chelan County has an interior or continental type of climate. Summers are warm and dry and the winters are cool, rainy and snowy. Climatic conditions are locally varied and greatly influenced by the mountains, which act as a barrier to the moist, prevailing westerly winds. The rise of humid Pacific Ocean air over this range, and its drying, warming and moderating descent into the Wenatchee, Entiat, Chelan and Columbia River Valleys create somewhat unique conditions ideally suited for the culture of fruit orchards. Major features are the good air drainage and the warming Chinook wind effect, which provide ideal seasonal temperature ranges for the budding, ripening and coloring of apples, pears, cherries and other fruit. Valley temperatures are normally mild and frost-free during the spring blossoming and pollination period, warm in mid-summer for ripening, then cool enough in early autumn for good coloring of fruit. Heavy rain and snowfall in the mountains provide a good irrigation water supply for the semi-arid lowlands at the eastern foot of the Cascades which are ditched for irrigation of over 25,000 acres of orchards.

Because of mountainous topography, the temperatures, frost conditions and growing seasons vary considerably by localities. In the narrow valleys they change sharply with a few hundred feet change in elevation. The lower Wenatchee

Table 6.- Temperature Extremes, Dates of Killing Frost
Chelan County

Station and Elevation	Temperature Extremes (degrees Fahrenheit)		Killing Frost Average Dates	
	Coldest	Hottest	Last in Spring	First in Fall
Blewett Pass (4,071)	-16	101	May 28	October 3
Domke Lake (2,213)	-13	100	May 15	October 13
Lakeside (1,110)	-15	106	April 9	October 25
Leavenworth (1,163)	-27	109	May 13	October 6
Stehekin (1,150)	-18	103	May 10	October 3
Wenatchee (634)	-29	110	April 24	October 14

Source: U.S. Dept. of Agric., Climate and Man, 1941 Yeabook of Agriculture.

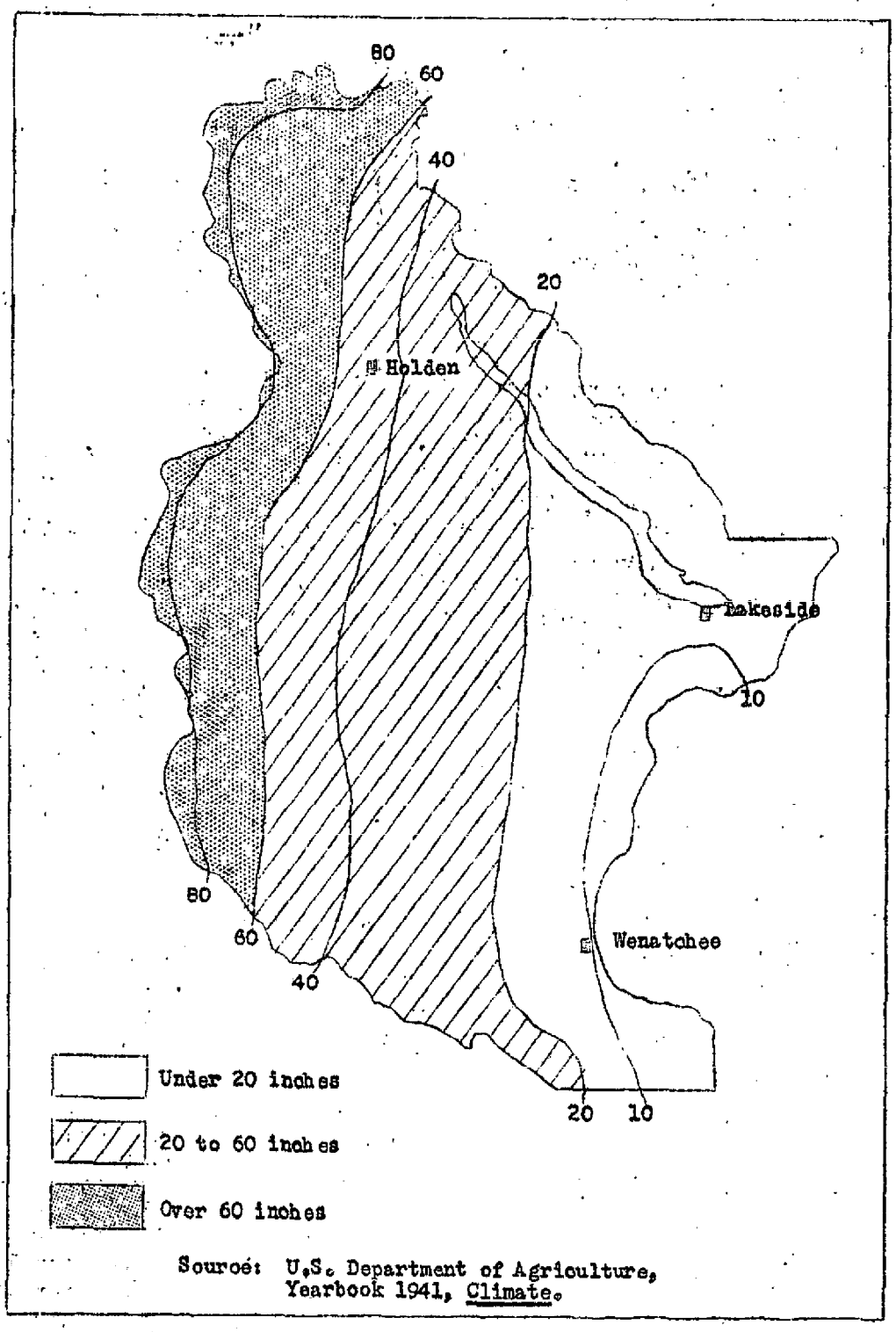

Figure Distribution of Precipitation
Chelan County

Valley has the warmest monthly and annual average temperatures and the longest growing season. At Wenatchee (634 feet) monthly averages are below freezing in December and January and average about 73 degrees in July. The Wenatchee growing season, free of killing frost, is normally 170 days, from late April to mid-October. Chelan Valley, being higher, has a slightly cooler climate and a shorter growing season. At Lakeside on Lake Chelan (1,110 feet), temperatures are below freezing in December and January and the growing season is about 160 days. Leavenworth (1,163 feet), in the upper Wenatchee Valley is still cooler, with a growing season of 150 days.

Chinook winds, warmed by air flowing down the eastern slope of the Cascades into the lower valley pockets are a feature of great benefit to the orchards in early spring. They provide good air drainage and minimize the buildup of heavy frosts in the lower valley terraces. Mild Pacific Ocean air of about 40 degrees in spring reaches the Cascade crest and has a temperature of 25 to 30 degrees at the 7,000 to 8,000 foot elevation. As the air descends into the Wenatchee, Entiat and Chelan Valleys it is warmed as it is squeezed into a smaller volume while flowing to a lower altitude. Because a cubic foot of air will be warmed about 5 degrees for each thousand feet of descent, it may have warmed to 50 to 55 degrees by the time it reaches the fruit-growing valley lowland. However, it becomes also a drying wind which evaporates soil moisture and necessitates irrigation. This warming and frost-preventing effect of the westerly Chinook winds helps orchard growing in several other foothill valleys such as the Methow, Okanogan, Kittitas and Yakima.

Table 7.- Temperatures For Selected Stations, By Months
Chelan County
(Source: United States Westher Bureau)

Station and Elevation in Feet	Average Temperatures (in degrees Fahrenheit)												Annual Average
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Holden (3,436)	20.7	30.4	29.4	36.8	47.5	50.7	58.7	56.8	52.1	39.4	35.7	24.5	40.2
Lakeside (1,110)	25.3	30.4	41.2	51.4	59.3	66.2	73.7	72.6	62.5	51.3	38.0	30.0	50.2
Wenatchee (634)	25.8	30.8	43.0	52.3	59.4	66.1	73.4	71.6	62.4	51.0	37.8	29.6	50.3

Precipitation varies considerably with changes in altitude from the Cascade summit to the Columbia River. The Cascade highland sections, including the Sawtooth Ridge and the other high divides such as Chelan Mountains, Entiat Mountains and Wenatchee Mountains receive annually from 20 to over 80 inches of precipitation. The Cascade crest is the wet zone of 60 to 80 inches or more, receiving a heavy annual snowfall. Lower valleys and the lowlands adjacent to the Columbia River are semi-arid with less than 20 inches. Wenatchee, on the Columbia River, has the driest record, an average of 8.75 inches. The wet alpine and mountain zone is a vital watershed supplying all the lower valley irrigation systems. Precipitation follows a sharp seasonal pattern with a wet period from October to April and a dry period during May, June, July, August and September. The dry season is accompanied by a high daily percentage of sunshine and hot mid-day temperatures, which cause crops to grow vigorously where irrigated.

Table 8.- Precipitation for Selected Stations By Months
Chelan County
(Source: United States Weather Bureau)

Station and Elevation in Feet	Average Monthly Precipitation (in inches)												Annual Total (inches)
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Holden (3,436)	4.17	3.98	2.83	1.36	1.17	1.10	.54	.59	1.41	4.27	4.73	6.70	32.95
Lakeside (1,110)	1.37	1.15	.79	.63	.83	.82	.29	.31	.54	.76	1.59	1.77	10.85
Wenatchee (634)	1.23	.92	.51	.33	.60	.68	.23	.24	.44	.72	1.19	1.66	8.75

Forests and Wildlife

Sharp variations in temperature and soil moisture caused by the valleys, hills and mountains create diverse types of vegetation and forest cover. The western half of Chelan County, which includes the high, rainy lands of the eastern Cascade slope, is a coniferous forest belt of pines, firs and hemlock. In the drier eastern half, vegetation consists of stunted conifers, merging into sagebrush and semi-arid scrub and grassland. Forest vegetation is dense in the narrow valleys of the mountains, such as the Stehekin, upper Entiat, Chiwawa and tributary valleys of the upper Wenatchee River.

A survey made in 1936 by the U. S. Forest Service shows Chelan to be an important forest resource county. 1/ About 80 percent of Chelan County's area or 1,492,000 acres is classified as forest land. Major forest tree species is Ponderosa pine growing on about 487,000 acres. Douglas fir and mixtures of mountain hemlock and alpine firs cover 284,000 acres. Lodgepole pine is third in importance and is found on 81,000 acres. Alpine firs and non-commercial alpine forest types cover approximately 417,000 acres. A small acreage of 2,000 acres or less are cottonwoods and aspen found along streams in the drier lowlands. The volume of merchantable timber of saw log size amounted to an estimated 5,283,550,000 board feet in 1936. Selective logging and other cutting since then has reduced the volume to below 4,000,000,000 feet.

Forest land ownership lies mainly with the federal government in three national forests: Snoqualmie, Chelan and Wenatchee National Forests. Over 70 percent of the stumpage of sawlog timber is federally owned, and the total land in national forests is 1,060,000 acres, or approximately 63 percent of all land in Chelan County. State-owned timber land amounts to about 34,000 acres. Private interests--railroads, timber companies and farm woodland owners--manage 341,000 acres of forested land, or about 18 percent of all the land in the county.

Forests play an important role in Chelan County agriculture. Under both public and private management, the forests conserve water for irrigation and provide some materials for farm buildings and fruit boxes.

1/ U. S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. Forest Statistics for Chelan County, Washington. (Mimeographed) May 25, 1936.